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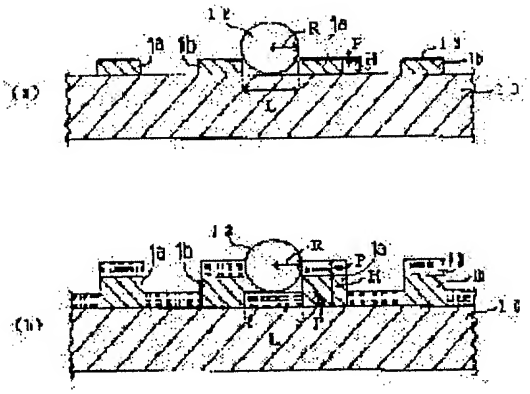
(54) SURFACE ACOUSTIC WAVE DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To manufacture a surface acoustic wave(SAW) device at a low cost with a simple process in which a short-circuit between electrode fingers due to deposition of a conductive foreign material is suppressed.
SOLUTION: A photosensing resist for lift-off is coated on a piezoelectric substrate 10 made of a 36° Y-cut - X propagation LiTaO3 crystal, a negative pattern of an interdigital transducer(IDT) electrode is formed and the width of electrode fingers 1a, 1b is selected to 1.1μm, and the interval between the electrode fingers 1a, 1b is selected to 1.1μm. Then an aluminum film is formed on the surface of the piezoelectric substrate on which the negative pattern is in existence by the thickness of 460nm by the vacuum vapor-deposition method and a silicon film for a protection film 13 is formed 35nm thick without breaking the vacuum state. The photosensing resist, the conductor film and the protection film 13 equivalent to the negative pattern of the piezoelectric substrate 10 are lifted off to manufacture the SAW device. The film thickness of the IDT electrodes of the SAW device is selected to 460nm and a half of the interval between the electrode fingers 1a and 1b of the SAW device is selected to 550nm.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] Surface acoustic wave equipment which arranges so that the electrode finger of the both sides of the ctenidium-like electrode of a pair which have two or more parallel electrode fingers on a piezo-electric substrate may gear mutually, and is surface acoustic wave equipment which prepares a protective coat only on a these ctenidium-like electrode, and changes, and is characterized by carrying out to less than [of spacing between the electrode fingers which adjoin the thickness of said ctenidium-like electrode] 1/2.
[Claim 2] The surface acoustic wave equipment which arranges so that the electrode finger of the both sides of the ctenidium-like electrode of a pair which have two or more parallel electrode fingers on a piezo-electric substrate may gear mutually, and is surface acoustic wave equipment which prepares a protective coat on a these ctenidium-like electrode and a piezo-electric substrate front face, and changes, and is characterized by to make the difference of the thickness of said ctenidium-like electrode, and the thickness of a protective coat less than [of spacing between adjoining electrode fingers] into 1/2.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is surface acoustic wave equipment for a resonator and frequency band filters built in mobile wireless devices, such as a land mobile radiotelephone and a cellular phone, and relates to the surface acoustic wave equipment considered as the configuration in which the electrode formed on the piezo-electric substrate controls the short-circuit by adhesion of a conductive foreign matter.
[0002]
[Description of the Prior Art] Conventional surface acoustic wave (it omits Surface Acoustic Wave and Following SAW) equipment is shown in drawing 2 , and the production process is shown in drawing 4 . Although (a) of drawing 2 prepared the partial expanded sectional view of SAW equipment and (b) prepared the protective coat, a partial expanded sectional view and (c) are the top views of the basic configuration of the whole equipment.
[0003] It sets to (a) of this drawing, and is LiNbO3. A crystal and LiTaO3 On the piezo-electric substrates 10, such as a crystal, the IDT (Inter Digital Transducer) electrode 11 of the ctenidium-like electrode arranged so that the predetermined spacing L may be set and two or more parallel electrode fingers 11a and 11b of each other may be clenched is formed. (b) is the configuration of having formed the insulating or semi-conductive protective coat 13 in the whole surface of the substrate side in which the IDT electrode 11 was formed, in order to hold the insulation between electrode finger 11a and 11b, when the conductive particle 12 adheres between electrode finger 11a and 11b [electrode finger 11a and 11b top or].
[0004] In (c) of this drawing, 11a was the electrode finger of an input side, 11b was the electrode finger of an output side, and when between electrode finger 11a and 11b flowed and short-circuited, the property as a resonator or a frequency band filter (henceforth a filter) had deteriorated. in addition -- general -- an IDT electrode -- a logarithm -- several 10 - a number -- although it was about 100, in (c), it drew typically.
[0005] Such SAW equipment is manufactured at a process as shown in drawing 4 . The photosensitive resist for lift off is applied on the piezo-electric substrate 10 at a process (a), and the negative pattern of the IDT electrode 11 is formed by the photolithography method at a process (b). After an appropriate time, at a process (c), the electric conduction film for IDT electrode 11 which consists of a metal or an alloy is formed in a vacuum ambient atmosphere by the thin film forming methods, such as vacuum deposition and the sputtering method, the piezo-electric substrate 10 is taken out out of a vacuum ambient atmosphere at a process (d), the photosensitive resist and electric conduction film of the negative pattern section are removed by the lift-off method (or the etching method), and the IDT electrode 11 of a request pattern is formed. And a protective coat 13 is made to form by vacuum deposition, the sputtering method, etc. on the IDT electrode 11 at a process (e). At this time, the piezo-electric substrate 10 was put in into the vacuum ambient atmosphere at 2 times of processes, (c) and (e).
[0006]
[Problem(s) to be Solved by the Invention] however -- if the protective coat 13 is not formed on the IDT electrode 11 -- abbreviation -- when the spherical conductive particle 12 adhered, there was a problem of between electrode finger 11a and 11b having flowed [the radius R] at the time of R>=L/2 (L being the distance between electrode finger 11a and 11b), and short-circuiting. Moreover, since a protective coat 13 cannot disregard the effect which it has on a resonator property or a filter shape even if it is going to form a protective coat 13 all over the substrate side in which the IDT electrode 11 was formed and is going to hold the insulation between electrode finger 11a and 11b, For example, thickness of a protective coat 13 had to be made thin as thickness of a protective coat 13 was set to about 50nm to about 500nm of thickness of the IDT electrode 11. Therefore, when the covering nature of a protective coat 13 was inadequate, and a protective coat 13 was not fully formed in the side face of the electrode fingers 11a and 11b, therefore R=L / about two particle 12 fitted in between electrode finger 11a and 11b exactly, it short-circuited through the side face of the electrode fingers 11a and 11b.
[0007] Moreover, when making a protective coat 13 form on the IDT electrode 11 by the thin film forming method for using vacuum devices, such as vacuum deposition and the sputtering method, the piezo-electric substrate 10 is again put in into the vacuum ambient atmosphere, and, for this reason, vacuum suction of vacuum devices needed to be performed twice [at least]. Furthermore, while taking the piezo-electric substrate 10 in and out out of the vacuum ambient atmosphere, the foreign matter might adhere on the piezo-electric substrate 10 or the IDT electrode 11.
[0008] Therefore, this invention is completed in view of the above-mentioned situation, the purpose controls the short-circuit between the electrode fingers by adhesion of a conductive foreign matter, and it is in manufacturing the SAW equipment of such a configuration to low cost at a simple process.
[0009]
[Means for Solving the Problem] The surface acoustic wave equipment of the 1st invention is arranged so that the electrode finger of the both sides of the ctenidium-like electrode of a pair which have two or more parallel electrode fingers on a piezo-electric substrate may gear mutually, and it is characterized by to carry out to less than [of spacing between the electrode fingers which are surface acoustic wave equipment which prepares a protective coat only on a these ctenidium-like electrode, and changes, and adjoin the thickness of said ctenidium-like electrode] 1/2.
[0010] The surface acoustic wave equipment of the 2nd invention is arranged so that the electrode finger of the both sides of the ctenidium-like electrode of a pair which have two or more parallel electrode fingers on a piezo-electric substrate may gear mutually. And it is surface acoustic wave equipment which prepares a protective coat in a these ctenidium-like electrode and a piezo-electric substrate front face, and grows into them, and is characterized by making the difference of the thickness of said

ctenidium-like electrode, and the thickness of a protective coat less than [of spacing between adjoining electrode fingers] into 1/2.

[0011]

[Embodiment of the Invention] Drawing 1 explains a production process for the surface acoustic wave equipment of this invention using drawing 3 . It is the partial expanded sectional view of SAW equipment [in / (a) of drawing 1 , and / in (b) / other operation gestalten]. [the partial expanded sectional view of SAW equipment] For a piezo-electric substrate and H, the thickness of an IDT electrode and L are [two or more parallel electrode fingers of the IDT electrode which is a ctenidium-like electrode of the pair arranged by (a) of this drawing, and (b) so that 1a and 1b may be clenched mutually, and 10 / the thickness of a protective coat 13 and R of spacing between electrode finger 1a and 1b and P] the radii of the conductive particle 12. (a) - (e) of drawing 3 explains the contents of each process briefly. In addition, in drawing 1 , the same sign is given to the same member as drawing 2 .

[0012] In 2 R<L, in (a) of drawing 1 , the electrode fingers 1a and 1b of the both sides of the ctenidium-like electrode of a pair do not short-circuit. In 2 R>L, a particle 12 adheres over two or more electrode fingers top, but since the protective coat 13 is formed on the IDT electrode (only on an IDT electrode), it does not short-circuit. Although a particle 12 may contact and short-circuit on the side face of the electrode fingers 1a and 1b in 2 R**L, with this operation gestalt, it is referred to as H<L/2, and the side face of the electrode fingers 1a and 1b has not reached the part of the maximum width of a particle 12. therefore, the probability which short-circuits through the side face of the electrode fingers 1a and 1b is markedly alike, and becomes small.

[0013] In 2 R<L and 2 R>L, in (b) of drawing 1 , it does not short-circuit like (a). Like H>=L/2, this operation gestalt is applied, when the thickness of an IDT electrode is comparatively thick, and the side face of the electrode fingers 1a and 1b has not reached the part of the maximum width of a particle 12 by setting to H-P<L/2 height H-P of the side face of the electrode fingers 1a and 1b exposed outside. therefore, the probability which short-circuits through the side face of the electrode fingers 1a and 1b is markedly alike, and becomes small.

[0014] For the above-mentioned protective coat 13, rho/P is 109, when it consists of an insulating or semi-conductive (half-conductivity) thing electrically and the resistivity of a protective coat is set to rho (ohm-cm). It is desirable to make it become the above (omega). As the ingredient, they are Ta, Mo and those oxides or a nitride, NiCr, NiCr-Si, Cr-SiO, Cr-SiO2, Si, SiO2, SiN, etc.

[0015] In this invention, it consists of aluminum or an aluminum alloy (an aluminum-Cu system, aluminum-Ti system, etc.), and especially aluminum has high excitation effectiveness, an IDT electrode has cheap ingredient cost and it is desirable. Moreover, although an electrode configuration is a configuration which engaged the ctenidium-like electrode for I/O (IDT electrode) as shown in drawing 1 by turns, this invention can apply two or more electrode fingers also to the thing of a slit mold like the reflector arranged in parallel. Furthermore, the cross-section configuration of the electrode fingers 1a and 1b is desirable when an inverse tapered shape mold which is tapering off toward a piezo-electric substrate side controls short-circuiting through the side face of the electrode fingers 1a and 1b.

[0016] The logarithm of an IDT electrode the width of face of 50 to about 200, and the electrode fingers 1a and 1b And about 0.1-10.0 micrometers, The crossover width of face of about 0.1-10.0 micrometers and the electrode fingers 1a and 1b is suitable for spacing between electrode finger 1a and 1b, when setting thickness of about 10-80 micrometers and an IDT electrode to about 0.2-0.4 micrometers acquires the expected property as a resonator or a filter. Moreover, if the reflector for reflecting SAW in the both ends of the propagation path of SAW of an IDT electrode, and resonating them efficiently may be prepared suitably and piezoelectric material, such as ZnO and AlO, is further formed between electrode finger 1a and 1b, the resonance effectiveness of SAW improves and is suitable.

[0017] As the above-mentioned piezo-electric substrate 10, it is LiTaO3 of 36 degreeY cut-X propagation, Crystal, LiNbO3 of 64 degreeY cut-X propagation LiB 4O7 of a crystal and 45-degreeX cut-Z propagation Crystal, Xtal etc. is suitable and it is LiTaO3 of 36 degreeY cut-X propagation especially. Pass band width is wide and a crystal is LiB 4O7 of 45-degreeX cut-Z propagation. Since [that an electromechanical coupling coefficient is large and] the group delay temperature coefficient of a crystal is small, it is desirable. The thickness of the piezo-electric substrate 10 has 0.3-0.5 goodmm, the piezo-electric substrate 10 becomes weak in less than 0.3mm, and cost becomes large in 0.5mm **.

[0018] in this way, this invention has the operation effectiveness of boiling markedly the short-circuit between the electrode fingers by adhesion of a conductive foreign matter, and controlling it.

[0019] Furthermore, the SAW equipment of this invention is manufactured as follows. In (a) of drawing 1 , the process of drawing 3 is followed. First, the photosensitive resist for lift off is applied on the piezo-electric substrate 10 at a process (a), and the negative pattern of an IDT electrode is formed by the photolithography method at a process (b). Then, the electric conduction film which consists of aluminum for IDT electrodes etc. in a vacuum ambient atmosphere is formed at a process (c) by the thin film forming methods, such as vacuum deposition, the sputtering method, and a CVD method. It is made for the thickness of the electric conduction film to become less than [of spacing between electrode finger 1a and 1b] 1/2 then. Next, a protective coat 13 is formed with vacuum deposition etc. on the near piezo-electric substrate front face in which the IDT electrode was formed, without breaking a vacuum at a process (d). 10-100nm is suitable for the thickness, and less than 10nm is not enough for it to function as an insulating protective coat 13, and it has big effect on a resonator property and a filter shape in 100nm **. And lift off of the photosensitive resist which is equivalent to the negative pattern section at a process (e), the electric conduction film, and the protective coat 13 is carried out to coincidence, and the SAW equipment of this invention is obtained.

[0020] In (b) of drawing 1 , the following processes are followed. First, on the piezo-electric substrate 10, the photosensitive resist for lift off is applied and the negative pattern of an IDT electrode is formed by the photolithography method. Then, the electric conduction film for IDT electrodes which consists of aluminum etc. is formed by the thin film forming methods, such as vacuum deposition, the sputtering method, and a CVD method. With a photosensitive resist, lift off of the electric conduction film equivalent to a negative pattern is carried out, it is removed, and an IDT electrode is formed. In addition, after an IDT electrode forms the electric conduction film first, applies a photosensitive resist and forms the positive pattern of an IDT electrode by the photolithography method, it may leave and form the electric conduction film equivalent to a positive pattern by the etching method.

[0021] Next, a protective coat is formed by the thin film forming methods, such as vacuum deposition, the sputtering method, and a CVD method. 10-100nm is suitable for the thickness like the case of (a) of drawing 1 . At this time, it is made for the difference of the thickness of an IDT electrode and the thickness of a protective coat 13 to become less than [of spacing between electrode finger 1a and 1b] 1/2, and the surface acoustic wave equipment of this invention is obtained.

[0022] In addition, this invention is not limited to the above-mentioned operation gestalt, and modification various by within the

limits which does not deviate from the summary of this invention does not interfere at all.
[0023]
[Example] The example of this invention is shown below.
[0024] (Example 1) It is the following, and the SAW equipment equivalent to (a) of drawing 1 was made and produced. LiTaO3 of 36 degreeY cut-X propagation On the piezo-electric substrate 10 which consists of a crystal, the photosensitive resist for lift off was applied and the negative pattern of an IDT electrode was formed by the photolithography method. At this time, conditions, such as the baking temperature of a photosensitive resist, BEKU time amount, ultraviolet-rays reinforcement at the time of exposure, the exposure time, a developer, and developing time, were adjusted, and that cross-section configuration was made into the inverse tapered shape configuration so that it might be easy to carry out lift off of the photosensitive resist. It is SAW LiTaO3 Since X shaft orientations of a crystal were made to spread, it was made for the longitudinal direction of the electrode fingers 1a and 1b to become perpendicular to X shaft orientations. Moreover, since about 900MHz signal is passed, in order to acquire a desired property, it was made for spacing whose width of face of the electrode fingers 1a and 1b is between 1.1 micrometers, electrode finger 1a, and 1b to be set to 1.1 micrometers.
[0025] Next, the piezo-electric substrate 10 was installed in the vacuum deposition inside of a plane, and 460nm of aluminum was formed on the near piezo-electric substrate front face in which the negative pattern was formed. At this time, the degree of vacuum in the chamber of a vacuum deposition machine was set to 10-7Torr. Then, 25nm of Si for protective coat 13 was formed, without breaking a vacuum. At this time, discharge took place between electrode finger 1a and 1b according to the pyroelectric effect of the piezo-electric substrate 10, and in order to avoid that the electrode fingers 1a and 1b are damaged, heating of the piezo-electric substrate 10 was not performed. And lift off of the photosensitive resist equivalent to the negative pattern of the piezo-electric substrate 10, the electric conduction film, and the protective coat 13 was carried out, the IDT electrode and the protective coat 13 were formed, and SAW equipment was produced.
[0026] The above-mentioned SAW equipment = (thickness of an IDT electrode) it was 460nm and, on the other hand, was =(1/2 of spacing between electrode finger 1a and 1b) 1.1 (micrometer) / 2= 550 (nm). By considering as said configuration, that whose percent defective was several % conventionally decreased to about 0.1%. Moreover, since vacuum suction was managed at once as compared with the former, the part SAW equipment has been manufactured to low cost.
[0027] (Example 2) It is the following, and the SAW equipment equivalent to (b) of drawing 1 was made and produced. LiTaO3 of 36 degreeY cut-X propagation On the piezo-electric substrate 10 which consists of a crystal, the photosensitive resist for lift off was applied and the negative pattern of an IDT electrode was formed by the photolithography method. At this time, conditions, such as the baking temperature of a photosensitive resist, BEKU time amount, ultraviolet-rays reinforcement at the time of exposure, the exposure time, a developer, and developing time, were adjusted, and that cross-section configuration was made into the inverse tapered shape configuration so that it might be easy to carry out lift off. It is SAW LiTaO3 Since X shaft orientations of a crystal were made to spread, it was made for the longitudinal direction of the electrode fingers 1a and 1b to become perpendicular to X shaft orientations. Moreover, since about 900MHz signal is passed, in order to acquire a desired property, it was made for spacing whose width of face of the electrode fingers 1a and 1b is between 1.1 micrometers, electrode finger 1a, and 1b to be set to 1.1 micrometers.
[0028] Next, the piezo-electric substrate 10 was installed in the vacuum deposition inside of a plane, and 460nm of aluminum was formed on the near piezo-electric substrate front face in which the negative pattern was formed. At this time, the degree of vacuum in the chamber of a vacuum deposition machine was set to 10-7Torr. Lift off of the photosensitive resist equivalent to the negative pattern of the piezo-electric substrate 10 after vacuum evaporationo was carried out, and the IDT electrode was formed. Then, the piezo-electric substrate 10 was installed in the vacuum deposition inside of a plane, vacuum suction was carried out to the 10-7Torr base, 25nm of Si for protective coat 13 was formed, and SAW equipment was produced. At this time, discharge took place between electrode fingers according to the pyroelectric effect of the piezo-electric substrate 10, and in order to avoid that an electrode finger is damaged, heating of the piezo-electric substrate 10 was not performed.
[0029] The above-mentioned SAW equipment is (thickness of IDT electrode)-(thickness of protective coat 13) =460-25=435(nm). On the other hand, since it is =(1/2 of spacing between electrode finger 1a and 1b) 1.1 (micrometer) / 2= 550 (nm), 435nm of differences of the thickness of an IDT electrode and the thickness of a protective coat 13 serves as one half of values of spacing between electrode finger 1a and 1b smaller than 550nm. By making it said configuration, the same effectiveness as an example 1 was acquired.
[0030]
[Effect of the Invention] a protective coat is prepared only on a ctenidium-like electrode and invention of the 1st of this invention does so the effectiveness that it boils markedly that a conductive foreign matter adheres at the time of assembly processing of packaging etc., and short-circuit occurs between electrode fingers, and can control, by making thickness of a ctenidium-like electrode less than [of spacing between electrode fingers] into 1/2. Moreover, since a ctenidium-like electrode and a protective coat can be formed continuously, without breaking a vacuum and a photolithography process can also be managed at once, a process is simplified. Furthermore, when releasing a vacuum, contamination of a foreign matter mixing and adhering into an ambient atmosphere from the exterior decreases. Since a protective coat is formed before finishing forming a ctenidium-like electrode, there is no discharge between the electrode fingers by the pyroelectric effect at the time of protective coat formation, and it also has the effectiveness that an electrode finger is not damaged.
[0031] moreover, a protective coat is prepared in a ctenidium-like electrode and a piezo-electric substrate front face, and by making the difference of the thickness of a ctenidium-like electrode, and the thickness of a protective coat less than [of spacing between electrode fingers] into 1/2, like the above, the 2nd invention boils markedly that short-circuit occurs, and can be controlled between electrode fingers. In this case, when it is not necessary to cover a protective coat on the side face of an electrode finger or and a protective coat is not covered with a certain cause by the side face of an electrode finger, short-circuit can be controlled if the thickness of a ctenidium-like electrode is adjusted like this invention. Therefore, since membranes can be formed also by the bad membrane formation equipment of covering nature, and the membrane formation approach, it is not restrained by membrane formation facility but manufacture becomes possible by low cost. Since covering of the side face of an electrode finger which membrane formation cannot carry out easily is not needed, thickness of a protective coat can be made thin, the tact time of membrane formation becomes short, and productivity is good. Moreover, effect on a resonator property and an SAW filter property can be made small by thin film-ization of a protective coat, therefore the degree of freedom of a design improves.
[0032] Furthermore, since the probability of this invention which short-circuits even if a conductive foreign matter adheres to some extent is quite small, it becomes unnecessary to wash too much the package which are the main generation sources of a

conductive foreign matter consequently, and it can simplify a production process.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Although the SAW equipment of this invention is shown and (a) has a protective coat only on an IDT electrode, although a partial expanded sectional view and (b) have a protective coat in the whole surface, they are a partial expanded sectional view.
[Drawing 2] Although conventional SAW equipment is shown and (a) does not have a protective coat, although a partial expanded sectional view and (b) have a protective coat in the whole surface, they are a partial expanded sectional view.
[Drawing 3] In the flow chart of the production process of the SAW equipment of this invention, (a) - (e) shows the contents of each process.
[Drawing 4] In the flow chart of the production process of conventional SAW equipment, (a) - (e) shows the contents of each process.
[Description of Notations]
1a: Electrode finger
1b: Electrode finger
10: A piezo-electric substrate
12: A conductive particle
13: Protective coat

[Translation done.]

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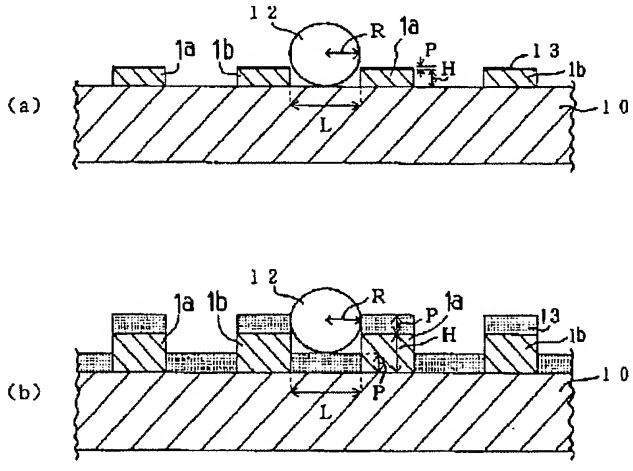
(54)【発明の名称】　弾性表面波装置

(57)【要約】
【課題】導電性の異物の付着による電極指間のショートを抑制し、ＳＡＷ装置を簡略な工程で低コストに製造する。
【解決手段】３６°ＹカットーＸ伝搬のＬｉＴａO_3結晶から成る圧電基板１０上にリフトオフ用の感光性レジストを塗布し、フォトリソグラフィー法によりＩＤＴ電極のネガパターンを形成し、電極指１ａ，１ｂの幅は１．１μｍ、電極指１ａ，１ｂ間の間隔は１．１μｍとした。次に、真空蒸着法によりネガパターンのある側の圧電基板表面にＡｌを４６０ｎｍ成膜し、真空を破らずに保護膜１３用のＳｉを３５ｎｍ成膜した。圧電基板１０のネガパターンに相当する感光性レジスト，導電膜，保護膜１３をリフトオフし、ＳＡＷ装置を作製した。ＳＡＷ装置は（ＩＤＴ電極の膜厚）＝４６０ｎｍで、（電極指１ａ，１ｂ間の間隔の１／２）＝５５０ｎｍであった。



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【特許請求の範囲】

【請求項１】圧電基板上に、複数の平行な電極指を有する一対の櫛歯状電極の双方の電極指が互いに噛み合うように配置し、かつこれら櫛歯状電極上のみに保護膜を設けて成る弾性表面波装置であって、前記櫛歯状電極の厚さを隣接する電極指間の間隔の１／２未満としたことを特徴とする弾性表面波装置。

【請求項２】圧電基板上に、複数の平行な電極指を有する一対の櫛歯状電極の双方の電極指が互いに噛み合うように配置し、かつこれら櫛歯状電極及び圧電基板表面に保護膜を設けて成る弾性表面波装置であって、前記櫛歯状電極の厚さと保護膜の膜厚との差を、隣接する電極指間の間隔の１／２未満としたことを特徴とする弾性表面波装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、自動車電話及び携帯電話等の移動体無線機器に内蔵される共振器及び周波数帯域フィルタ用の弾性表面波装置であって、圧電基板上に形成された電極が、導電性の異物の付着によるショートを抑制する構成とされた弾性表面波装置に関する。

【０００２】

【従来の技術】従来の弾性表面波（Surface Acoustic Wave 、以下ＳＡＷと略す）装置を図２に、その製造工程を図４に示す。図２の（ａ）はＳＡＷ装置の部分拡大断面図、（ｂ）は保護膜を設けたものの部分拡大断面図、（ｃ）は装置全体の基本構成の平面図である。

【０００３】同図の（ａ）において、$LiNbO_3$ 結晶，$LiTaO_3$ 結晶等の圧電基板１０上に、所定の間隔Ｌをおいて複数の平行な電極指１１ａ，１１ｂが互いに噛み合わされるように配置された、櫛歯状電極のＩＤＴ（Inter Digital Transducer）電極１１が設けられている。（ｂ）は、電極指１１ａ，１１ｂ上若しくは電極指１１ａ，１１ｂ間に導電性の微粒子１２が付着した場合に、電極指１１ａ，１１ｂ間の絶縁性を保持するために、ＩＤＴ電極１１が設けられた基板面の全面に絶縁性又は半導電性の保護膜１３を設けた構成である。

【０００４】同図の（ｃ）において、１１ａは例えば入力側の電極指で、１１ｂは例えば出力側の電極指であり、電極指１１ａと１１ｂ間が導通しショートすると、共振器や周波数帯域フィルタ（以下フィルタという）としての特性が劣化していた。尚、一般的に、ＩＤＴ電極対数は数１０～数１００程度であるが、（ｃ）では模式的に描いた。

【０００５】このようなＳＡＷ装置は、図４に示すような工程で製造される。工程（ａ）で圧電基板１０上にリフトオフ用の感光性レジストを塗布し、工程（ｂ）でフォトリソグラフィー法によりＩＤＴ電極１１のネガパターンを形成する。しかる後、工程（ｃ）で蒸着法やスパッタリング法等の薄膜形成法により、金属又は合金から

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成るＩＤＴ電極１１用の導電膜を真空雰囲気中で成膜し、工程（ｄ）で圧電基板１０を真空雰囲気中から取り出し、リフトオフ法（またはエッチング法）によりネガパターン部の感光性レジストと導電膜を除去し、所望パターンのＩＤＴ電極１１を形成する。そして、工程（ｅ）でＩＤＴ電極１１上に蒸着法やスパッタリング法等で保護膜１３を形成させる。このとき、（ｃ）と（ｅ）の２回の工程で、圧電基板１０を真空雰囲気中に入れていた。

【０００６】

【発明が解決しようとする課題】しかしながら、ＩＤＴ電極１１上に保護膜１３が設けられていないと、略球状の導電性の微粒子１２が付着した場合、その半径ＲがＲ≧Ｌ／２（Ｌは電極指１１ａ，１１ｂ間の距離）のとき、電極指１１ａ，１１ｂ間が導通しショートするという問題があった。また、ＩＤＴ電極１１が設けられた基板面の全面に保護膜１３を設けて、電極指１１ａ，１１ｂ間の絶縁を保持しようとしても、保護膜１３が共振器特性やフィルタ特性に与える影響が無視できないため、例えばＩＤＴ電極１１の膜厚５００ｎｍ程度に対して保護膜１３の膜厚を５０ｎｍ程度にするというように、保護膜１３の膜厚を薄くせざるをえなかった。そのため保護膜１３の被覆性が不充分で、電極指１１ａ，１１ｂの側面には保護膜１３が充分に形成されず、従って、ちょうどＲ＝Ｌ／２程度の微粒子１２が電極指１１ａ，１１ｂ間に嵌まり込んだ場合に、電極指１１ａ，１１ｂの側面を通じてショートしていた。

【０００７】また、ＩＤＴ電極１１上に蒸着法やスパッタリング法等の真空装置を利用する薄膜形成法で保護膜１３を形成させる場合に、圧電基板１０を再度真空雰囲気中に入れており、このため、真空装置の真空引きを最低２度行う必要があった。更に、圧電基板１０を真空雰囲気中に出し入れする間に、圧電基板１０やＩＤＴ電極１１上に異物が付着することがあった。

【０００８】従って、本発明は上記事情に鑑みて完成されたものであり、その目的は導電性の異物の付着による電極指間のショートを抑制し、そのような構成のＳＡＷ装置を簡略な工程で低コストに製造することにある。

【０００９】

【課題を解決するための手段】第１の発明の弾性表面波装置は、圧電基板上に、複数の平行な電極指を有する一対の櫛歯状電極の双方の電極指が互いに噛み合うように配置し、かつこれら櫛歯状電極上のみに保護膜を設けて成る弾性表面波装置であって、前記櫛歯状電極の厚さを隣接する電極指間の間隔の１／２未満としたことを特徴とする。

【００１０】第２の発明の弾性表面波装置は、圧電基板上に、複数の平行な電極指を有する一対の櫛歯状電極の双方の電極指が互いに噛み合うように配置し、かつこれら櫛歯状電極及び圧電基板表面に保護膜を設けて成る弾

性表面波装置であって、前記櫛歯状電極の厚さと保護膜の膜厚との差を、隣接する電極指間の間隔の１／２未満としたことを特徴とする。

【００１１】

【発明の実施の形態】本発明の弾性表面波装置を図１で、製造工程を図３を用いて説明する。図１の（ａ）はＳＡＷ装置の部分拡大断面図、（ｂ）は他の実施形態におけるＳＡＷ装置の部分拡大断面図である。同図の（ａ），（ｂ）で、１ａ，１ｂは、互いに噛み合わされるように配置された一対の櫛歯状電極であるＩＤＴ電極の複数の平行な電極指、１０は圧電基板、ＨはＩ ＤＴ電極の膜厚、Ｌは電極指１ａ，１ｂ間の間隔、Ｐは保護膜１３の膜厚、Ｒは導電性の微粒子１２の半径である。図３の（ａ）～（ｅ）は各工程の内容を簡単に説明したものである。尚、図１において、図２と同じ部材には同じ符号を付している。

【００１２】図１の（ａ）において、２Ｒ＜Ｌの場合に一対の櫛歯状電極の双方の電極指１ａ，１ｂがショートすることはない。２Ｒ＞Ｌの場合には、微粒子１２が複数の電極指上にわたって付着するが、ＩＤＴ電極上（ＩＤＴ電極上のみ）に保護膜１３が設けられているのでショートすることはない。２Ｒ≒Ｌでは、微粒子１２が電極指１ａ，１ｂの側面に接触してショートする可能性があるが、本実施形態では、Ｈ＜Ｌ／２とされており、電極指１ａ，１ｂの側面が微粒子１２の最大幅の部分に達していない。従って、電極指１ａ，１ｂの側面を通じてショートする確率が格段に小さくなる。

【００１３】図１の（ｂ）において、２Ｒ＜Ｌ及び２Ｒ＞Ｌの場合には、（ａ）と同様にショートすることはない。本実施形態は、Ｈ≧Ｌ／２のようにＩＤＴ電極の膜厚が比較的厚い場合に適用され、外部に露出している電極指１ａ，１ｂの側面の高さＨ－ＰをＨ－Ｐ＜Ｌ／２とすることにより、電極指１ａ，１ｂの側面が微粒子１２の最大幅の部分に達していない。従って、電極指１ａ，１ｂの側面を通じてショートする確率が格段に小さくなる。

【００１４】上記保護膜１３は電気的に絶縁性又は半導電性（半導伝性）のものから成り、保護膜の抵抗率をρ（Ω・ｃｍ）としたとき、ρ／Ｐが10^9（Ω）以上となるようにするのが好ましい。その材料としては、Ｔａ，Ｍｏ及びそれらの酸化物若しくは窒化物，ＮｉＣｒ，ＮｉＣｒ－Ｓｉ，Ｃｒ－ＳｉＯ，Ｃｒ－SiO_2，Ｓｉ，SiO_2，ＳｉＮ等である。

【００１５】本発明において、ＩＤＴ電極はＡｌあるいはＡｌ合金（Ａｌ－Ｃｕ系，Ａｌ－Ｔｉ系等）からなり、特にＡｌが励振効率が高く、材料コストが安価であり好ましい。また、電極形状は図１に示すような入出力用の櫛歯状電極（ＩＤＴ電極）を交互に噛み合わせたような形状であるが、本発明は、複数の電極指を平行に配置した反射器のようなスリット型のものにも適用できる。更に、電極指１ａ，１ｂの断面形状は、圧電基板面に向かって先細りとなるような逆テーパー型が、電極指１ａ，１ｂの側面を通じてショートするのを抑制するうえで好ましい。

【００１６】そして、ＩＤＴ電極の対数は５０～２００程度、電極指１ａ，１ｂの幅は０．１～１０．０μｍ程度、電極指１ａ，１ｂ間の間隔は０．１～１０．０μｍ程度、電極指１ａ，１ｂの交差幅は１０～８０μｍ程度、ＩＤＴ電極の厚みは０．２～０．４μｍ程度とすることが、共振器あるいはフィルタとしての所期の特性を得るうえで好適である。また、ＩＤＴ電極のＳＡＷの伝搬路の両端に、ＳＡＷを反射し効率良く共振させるための反射器を適宜設けてもよく、更には、電極指１ａ，１ｂ間にＺｎＯ，ＡｌＯ等の圧電材料を成膜すれば、ＳＡＷの共振効率が向上し好適である。

【００１７】上記圧電基板１０としては、３６°Ｙカット－Ｘ伝搬の$LiTaO_3$結晶、６４°Ｙカット－Ｘ伝搬の$LiNbO_3$結晶、４５°Ｘカット－Ｚ伝搬の$Li_2B_4O_7$結晶、水晶等が好適であり、特に３６°Ｙカット－Ｘ伝搬の$LiTaO_3$結晶は通過帯域幅が広く、また４５°Ｘカット－Ｚ伝搬の$Li_2B_4O_7$結晶は電気機械結合係数が大きくかつ群遅延時間温度係数が小さいため好ましい。圧電基板１０の厚みは０．３～０．５ｍｍがよく、０．３ｍｍ未満では圧電基板１０が脆くなり、０．５ｍｍ超ではコストが大きくなる。

【００１８】かくして、本発明は、導電性の異物の付着による電極指間のショートを格段に抑制するという作用効果を有する。

【００１９】更に、本発明のＳＡＷ装置は以下のように製造される。図１の（ａ）の場合、図３の工程に従う。まず、工程（ａ）で圧電基板１０上にリフトオフ用の感光性レジストを塗布し、工程（ｂ）でフォトリソグラフィー法によりＩＤＴ電極のネガパターンを形成する。その後、工程（ｃ）で蒸着法，スパッタリング法，ＣＶＤ法等の薄膜形成法により、真空雰囲気中でＩＤＴ電極用のＡｌ等から成る導電膜を成膜する。そのとき、導電膜の膜厚が電極指１ａ，１ｂ間の間隔の１／２未満となるようにする。次に、工程（ｄ）で真空を破らずに、ＩＤＴ電極が形成された側の圧電基板表面に保護膜１３を蒸着法等により成膜する。その膜厚は１０～１００ｎｍが好適であり、１０ｎｍ未満では絶縁性の保護膜１３として機能するのに充分でなく、１００ｎｍ超では共振器特性及びフィルタ特性に大きな影響を与える。そして、工程（ｅ）でネガパターン部に相当する感光性レジスト，導電膜，保護膜１３を同時にリフトオフし、本発明のＳＡＷ装置を得る。

【００２０】図１の（ｂ）の場合は以下の工程に従う。まず、圧電基板１０上にリフトオフ用の感光性レジストを塗布し、フォトリソグラフィー法によりＩＤＴ電極のネガパターンを形成する。その後、蒸着法，スパッタリ

ング法，ＣＶＤ法等の薄膜形成法により、Ａｌ等から成るＩＤＴ電極用の導電膜を成膜する。ネガパターンに相当する導電膜を、感光性レジストとともにリフトオフして除去しＩＤＴ電極を形成する。尚、ＩＤＴ電極は、まず導電膜を形成して感光性レジストを塗布し、フォトリソグラフィー法によりＩＤＴ電極のポジパターンを形成した後、エッチング法によってポジパターンに相当する導電膜を残して形成してもかまわない。

【００２１】次に、蒸着法，スパッタリング法，ＣＶＤ法等の薄膜形成法により保護膜を形成する。その膜厚は、図１の（ａ）の場合と同様に１０～１００ｎｍが好適である。このとき、ＩＤＴ電極の膜厚と保護膜１３の膜厚との差が、電極指１ａ，１ｂ間の間隔の１／２未満になるようにし、本発明の弾性表面波装置を得る。

【００２２】尚、本発明は上記の実施形態に限定されるものではなく、本発明の要旨を逸脱しない範囲内で種々の変更は何等差し支えない。

【００２３】

【実施例】本発明の実施例を以下に示す。

【００２４】（実施例１）図１の（ａ）に相当するＳＡＷ装置を以下のようにして作製した。３６°ＹカットーＸ伝搬のＬｉＴａO_3結晶から成る圧電基板１０上に、リフトオフ用の感光性レジストを塗布し、フォトリソグラフィー法によりＩＤＴ電極のネガパターンを形成した。このとき、感光性レジストのベーク温度、ベーク時間、露光時の紫外線強度、露光時間、現像液、現像時間等の条件を調整して、感光性レジストをリフトオフしやすいようにその断面形状を逆テーパー形状とした。ＳＡＷをＬｉＴａO_3結晶のＸ軸方向に伝搬させるので、電極指１ａ，１ｂの長手方向はＸ軸方向に対して垂直になるようにした。また、約９００ＭＨｚ程度の信号を通過させるので、所望の特性を得るために、電極指１ａ，１ｂの幅が１．１μｍ、電極指１ａ，１ｂ間の間隔が１．１μｍとなるようにした。

【００２５】次に、圧電基板１０を真空蒸着機内に設置し、そのネガパターンが形成された側の圧電基板表面にＡｌを４６０ｎｍ成膜した。このとき、真空蒸着機のチャンバー内の真空度は10^{-7}Ｔｏｒｒとした。その後、真空を破らずに保護膜１３用のＳｉを２５ｎｍ成膜した。このとき、圧電基板１０の焦電効果により電極指１ａ，１ｂ間に放電が起こり、電極指１ａ，１ｂが損傷するのを避けるため、圧電基板１０の加熱は行わなかった。そして、圧電基板１０のネガパターンに相当する感光性レジスト，導電膜，保護膜１３をリフトオフし、ＩＤＴ電極及び保護膜１３を形成し、ＳＡＷ装置を作製した。

【００２６】上記ＳＡＷ装置は、（ＩＤＴ電極の膜厚）＝４６０ｎｍで、一方、（電極指１ａ，１ｂ間の間隔の１／２）＝１．１（μｍ）／２＝５５０（ｎｍ）であった。前記構成とすることにより、従来不良率が数％であったものが、０．１％程度に減少した。また、従来に比較して真空引きが１回で済むため、その分ＳＡＷ装置を低コストに製造できた。

【００２７】（実施例２）図１の（ｂ）に相当するＳＡＷ装置を以下のようにして作製した。３６°ＹカットーＸ伝搬のＬｉＴａO_3結晶から成る圧電基板１０上に、リフトオフ用の感光性レジストを塗布し、フォトリソグラフィー法によりＩＤＴ電極のネガパターンを形成した。このとき、感光性レジストのベーク温度、ベーク時間、露光時の紫外線強度、露光時間、現像液、現像時間等の条件を調整して、リフトオフしやすいようにその断面形状を逆テーパー形状とした。ＳＡＷをＬｉＴａO_3結晶のＸ軸方向に伝搬させるので、電極指１ａ，１ｂの長手方向はＸ軸方向に対して垂直になるようにした。また、約９００ＭＨｚ程度の信号を通過させるので、所望の特性を得るために、電極指１ａ，１ｂの幅が１．１μｍ、電極指１ａ，１ｂ間の間隔が１．１μｍとなるようにした。

【００２８】次に、圧電基板１０を真空蒸着機内に設置し、そのネガパターンが形成された側の圧電基板表面にＡｌを４６０ｎｍ成膜した。このとき、真空蒸着機のチャンバー内の真空度は10^{-7}Ｔｏｒｒとした。蒸着後の圧電基板１０のネガパターンに相当する感光性レジストをリフトオフし、ＩＤＴ電極を形成した。その後、圧電基板１０を真空蒸着機内に設置し、10^{-7}Ｔｏｒｒ台まで真空引きし、保護膜１３用のＳｉを２５ｎｍ成膜してＳＡＷ装置を作製した。このとき、圧電基板１０の焦電効果により電極指間に放電が起こり、電極指が損傷するのを避けるため、圧電基板１０の加熱は行わなかった。

【００２９】上記ＳＡＷ装置は、（ＩＤＴ電極の膜厚）－（保護膜１３の膜厚）＝４６０－２５＝４３５（ｎｍ）で、一方、（電極指１ａ，１ｂ間の間隔の１／２）＝１．１（μｍ）／２＝５５０（ｎｍ）であるので、ＩＤＴ電極の膜厚と保護膜１３の膜厚の差４３５ｎｍが、電極指１ａ，１ｂ間の間隔の１／２の５５０ｎｍよりも小さい値となっている。前記構成にすることにより、実施例１と同様の効果が得られた。

【００３０】

【発明の効果】本発明の第１の発明は、櫛歯状電極上のみに保護膜が設けられ、櫛歯状電極の膜厚を電極指間の間隔の１／２未満とすることにより、パッケージング等の組み立て加工時に導電性の異物が付着して電極指間にショートが発生するのを格段に抑制できるという効果を奏する。また、真空を破らずに櫛歯状電極と保護膜を連続で成膜でき、フォトリソグラフィー工程も１回で済むので、工程が簡略化される。更に、真空を解放するときに外部から雰囲気中に異物が混入して付着する等の汚染が低減する。櫛歯状電極を形成し終わる前に保護膜を成膜するので、保護膜形成時の焦電効果による電極指間の放電がなく、電極指が損傷しないという効果も有する。

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【００３１】また、第２の発明は、櫛歯状電極及び圧電基板表面に保護膜が設けられ、櫛歯状電極の膜厚と保護膜の膜厚との差を電極指間の間隔の１／２未満とすることにより、上記と同様に電極指間にショートが発生するのを格段に抑制できる。この場合、電極指の側面に保護膜を被覆する必要はなく、あるいは何らかの原因により電極指の側面に保護膜が被覆されなかったとき、本発明のように櫛歯状電極の膜厚を調整しておけばショートを抑制することができる。従って、被覆性の悪い成膜装置，成膜方法でも成膜できるので、成膜設備に制約されず低コストで製造可能となる。成膜のしにくい電極指の側面の被覆を必要としないので、保護膜の膜厚を薄くでき、成膜のタクトタイムが短くなり生産性がよい。また、保護膜の薄膜化により共振器特性及びＳＡＷフィルタ特性への影響を小さくでき、故に設計の自由度が向上する。

【００３２】更に、本発明は、導電性の異物がある程度付着してもショートする確率がかなり小さいため、導電性の異物の主な発生源であるパッケージを余分に洗浄す＊

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＊る必要がなくなり、その結果、製造工程が簡略化できる。

【図面の簡単な説明】

【図１】本発明のＳＡＷ装置を示し、（ａ）はＩＤＴ電極上にのみ保護膜があるものの部分拡大断面図、（ｂ）は全面に保護膜があるものの部分拡大断面図である。

【図２】従来のＳＡＷ装置を示し、（ａ）は保護膜がないものの部分拡大断面図、（ｂ）は全面に保護膜があるものの部分拡大断面図である。

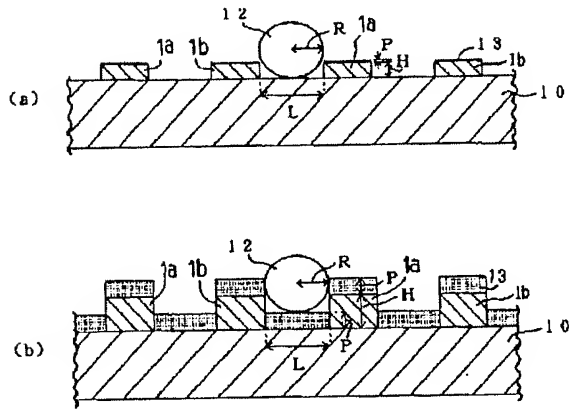
【図３】本発明のＳＡＷ装置の製造工程の流れ図で、（ａ）～（ｅ）は各工程の内容を示す。

【図４】従来のＳＡＷ装置の製造工程の流れ図で、（ａ）～（ｅ）は各工程の内容を示す。

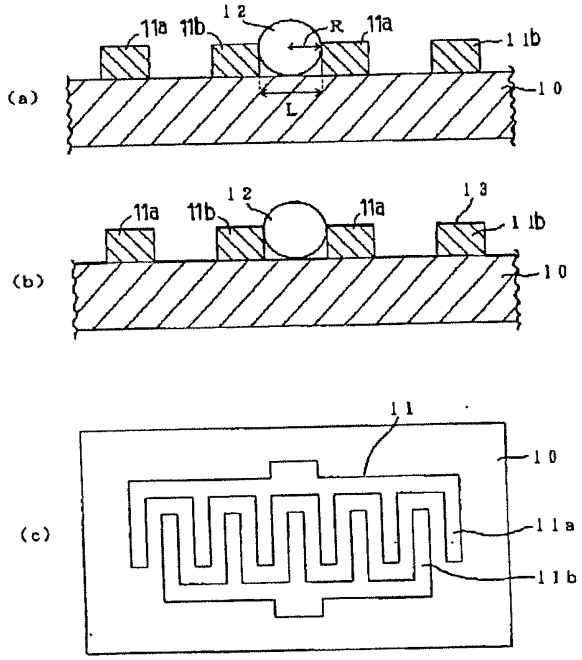
【符号の説明】

１ａ：電極指
１ｂ：電極指
１０：圧電基板
１２：導電性の微粒子
１３：保護膜

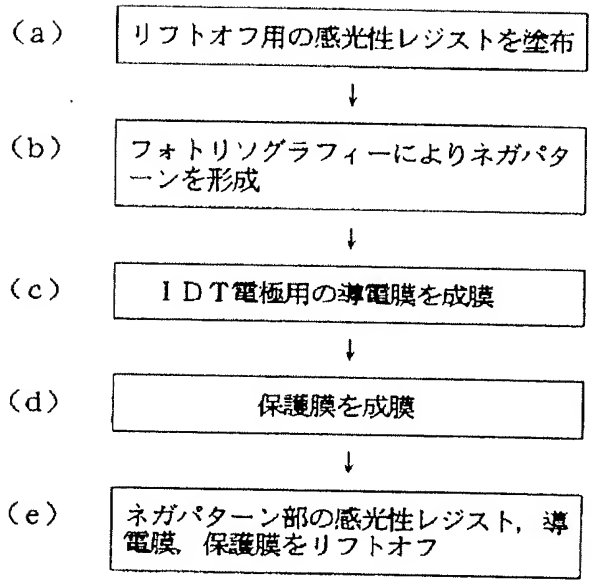
【図１】



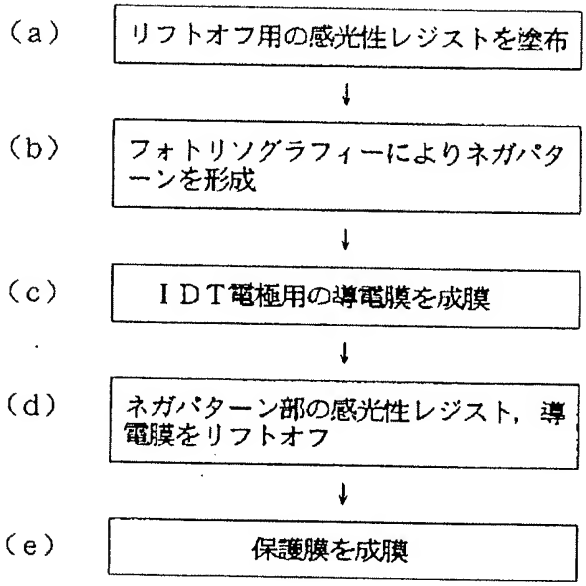
【図２】



【図３】



【図４】



【手続補正書】
【提出日】平成８年１２月１０日
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】図２
【補正方法】変更
＊【補正内容】
【図２】従来のＳＡＷ装置を示し、（ａ）は保護膜がないものの部分拡大断面図、（ｂ）は全面に保護膜があるものの部分拡大断面図、（ｃ）はＳＡＷ装置全体の基本構成の平面図である。

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